Equipment performance benchmarking

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The Equipment Performance Benchmarking Project was initiated under the directive of the Surface Mining Association for Research and Technology (SMART) to establish a secure method of comparing equipment productivity and maintenance KPIs between surface mining companies. Participants submit detailed data gathered from production monitoring systems on information related to standard time-related metrics such as production, availability and utilization. The data are normalized, based on a series of common performance definitions, and reported on a web-based system in a secure format that preserves subscriber anonymity. The Benchmarking Project provides the tools for mining companies to assess fleet operations and maintenance practices, to compare their relative performance against other companies, and to identify leaders in the industry. The distinctive characteristic of the SMART Benchmarking Project is the collaborative spirit of the participating companies to identify the underlying Best Practices and to work together to share information, with the goal to promoting continuous improvement in the mining industry. The Benchmarking Project is described in this paper and its capabilities are reviewed.

Keywords: benchmarking, equipment performance, Best Practices, KPIs, surface mining

1. Introduction

To be competitive in today's global industry, it is important for a company to be able to compare its performance against others and to gauge its progress in key dimensions to leaders in the industry. To achieve this, many industry sectors, including Manufacturing, Refining and Utilities, have instituted benchmarking of Key Performance Indicators (KPIs) as standard practice. As well as ranking company performance, benchmarking can be used as the basis for improving operations and practices and to promote innovation and kindle continuous improvement efforts.

The mining industry, in general, has lagged behind other industries in the adoption of benchmarking. Partially, this is because of a reluctance to share information due to confidentiality and privacy concerns; there is a particular sensitivity when cost data is concerned. The lack of common performance definitions has also hindered the ability to compare performance between mining operations.

In the past few years, with the support of the Surface Mining Association for Research and Technology (SMART), the surface mining industry has made significant inroads into benchmarking. SMART, an organization with some 25 mining firms worldwide and four universities, was formed to foster a coordinated approach to technology development in the

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mining industry. The association provides a forum for mining companies to join forces and work together to meet common needs. The key focus is to share information, stay abreast of new technologies and effectively focus research are capabilities critical to maintaining a competitive edge.

SMART recognized the benefits of establishing an inter-company database to collect KPIs related to mining equipment productivity and maintenance. Benchmarking of equipment metrics is a useful tool to achieve improved fleet operations and maintenance practices. It can also be utilized to identify leaders in the industry and the underlying Best Practices. These can then be implemented to increase mine productivity and hence lower cost per tonne of material moved.

2. Project directives

The SMART Benchmarking Project was initiated in 2003 with three oil sands surface mining companies in Alberta, Canada. The project currently has 8 participating companies and 9 mines representing operations in iron ore, gold, diamonds, coal and oil sands mining. The database now regularly reports on the performance of approximately 300 haul trucks and 70 shovels across the mining industry. SMART's vision is to provide a means for low-cost continuous benchmarking that will expand to a world-wide system that includes all types of surface mining operations.

SMART identified that, to ensure success of the project and to promote the participating of mining companies, it was important to ensure confidentiality of information for the participants. An independent 3rd party was therefore required to administer the project. Marston & Marston, Inc. (Marston), an international mine engineering consulting firm, was contracted to develop and administer the project. All original data from participating companies flows through Marston to ensure security of data and all reported data is tagged with random alpha designators to preserve subscriber anonymity. Distribution of the benchmarking reports is limited to participating companies and each participant must sign a Confidentiality Agreement to control data usage to internal applications.

SMART directives were to develop a low-cost sustainable benchmarking system that would easily accommodate new mining participants over time. The project development was therefore designed in a staged format, so that new mining firms can join the already participating mining firms at any time. This has kept costs to a minimum and enabled ongoing expansion of the program capability to ensure viability for all participants.

The initial step to the project development included identifying a series of common metric definitions that were agreed to by multiple participants. A survey of mining companies found that, although formulas and definitions utilized to measure standard equipment performance such as availability and utilization were similar, there were differences in the meanings behind the formulae and the classification of events in the course of operations. This lead to inconsistencies in classification of operating events, time categories, and reporting and therefore difficulties in comparing equipment performance between mines. To allow industry-wide comparison, data supplied from mines needed to be validated and normalized to common definitions.

An early study focused on identifying the fundamental differences between the way mining operations classify normal operating events and define maintenance performance

parameters and on developing a series of common definitions for key performance parameters. The benchmarking definitions derived for this purpose were the first step toward development of an industry standard for selected operating measures.

3. Participation

On initiation, Marston works with each new participant to establish data transfer protocol and definitions of data categorization and normalization. Once set-up is complete, participating companies submit data on a quarterly basis. Since information is exchanged from the company's existing data systems, set-up costs are kept to a minimum. Marston will travel to the mine sites to assist with initial set-up or, as is possible in most cases, set-up is completed remotely.

Participating company pays an initial set-up fee and a one-time development fee (fixed by SMART) to help fund on-going development and improvement of the system. A nominal subscription fee is then invoiced for quarterly benchmarking reports.

Information collected the mines includes data related to standard time-related metrics such as production, availability, utilization and other time-based metrics for trucks, shovels and major support equipment. Data from each mine is then normalized to ensure comparability. This begins with the simple categorization of 24 hours for each measured piece of equipment. Figure 1 reflects the major time classifications used within the mining industry. All events encountered in the course of operating a mine must fall into one of these time classifications.

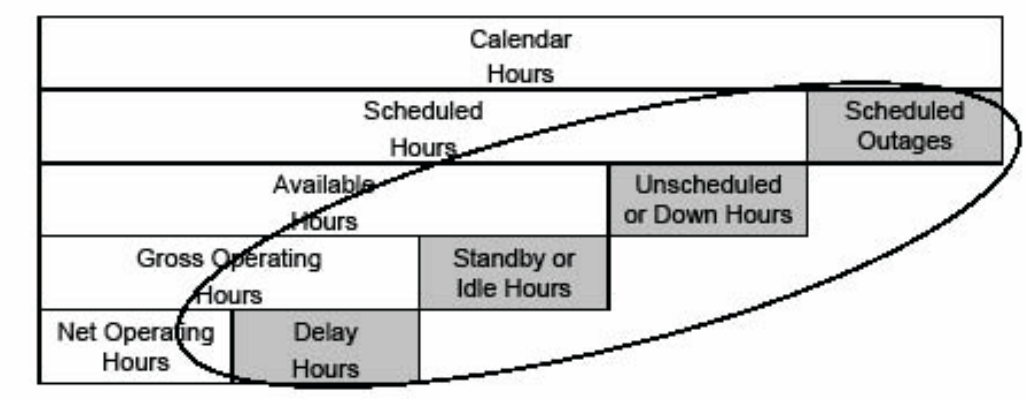


Figure 1. Time classification model.

General categories of "Operating Delays", "Maintenance Downtime", "Standby," and "Scheduled Downtime" are used to frame comparisons. Equipment hours for each mine are categorized according to accepted definitions and the validity of the submitted data validated. Data is then normalized using a generic set of normalized KPIs to allow for cross-company evaluation of equipment productivity.

Results are reported quarterly. All reported results are summarized and tagged with random alpha designators to preserve subscriber anonymity. Only the owner of the data knows which letter represents their mine.

4. System development

4.1 Phase 1: Preliminary system

The first phase of the project was developed using an Access™ database. Reporting was in the form of Excel™ spreadsheet deliverables that were emailed to participants on a quarterly basis. This system required that all data collection and processing was done on a manual basis. Although this system functioned well for a small number of participants, several limitations were identified. These included:

- there was no interactive client interface;
- no real-time access to the reports existed;
- user-based querying and visualization was not possible;
- there was limited visualization and reporting options;
- graphs became too crowded as the number of participants and total time frame increased; it was only possible to view all data and the total timeline; and,
- no security to overall metrics database was provided.

As the number of mines increased, it was determined that more functionality was needed in the system.

4.2 Phase 2: Web-based system

The second generation system is being rolled out in 2008. This system provides automated data import, normalization and processing for existing participants using Microsoft Integration Services. Data from companies can be quickly imported from Excel™ file or flat data files, with error checking for uncorrelated time codes.

A web site was built using Microsoft's ASP.NET technology that provides participants with direct access to the reports. Enhanced security has been incorporated and access is controlled by the implementation of a login password system. Data is stored in a Microsoft SQL Server 2005 database that can handle an unlimited number of participants. Reports are displayed in web pages using Microsoft's Reporting Services and Dundas™ Charts was incorporated to provide improved graphics.

The system configuration in Figure 2 illustrates the data flow and storage methodology in place for the web-based system.

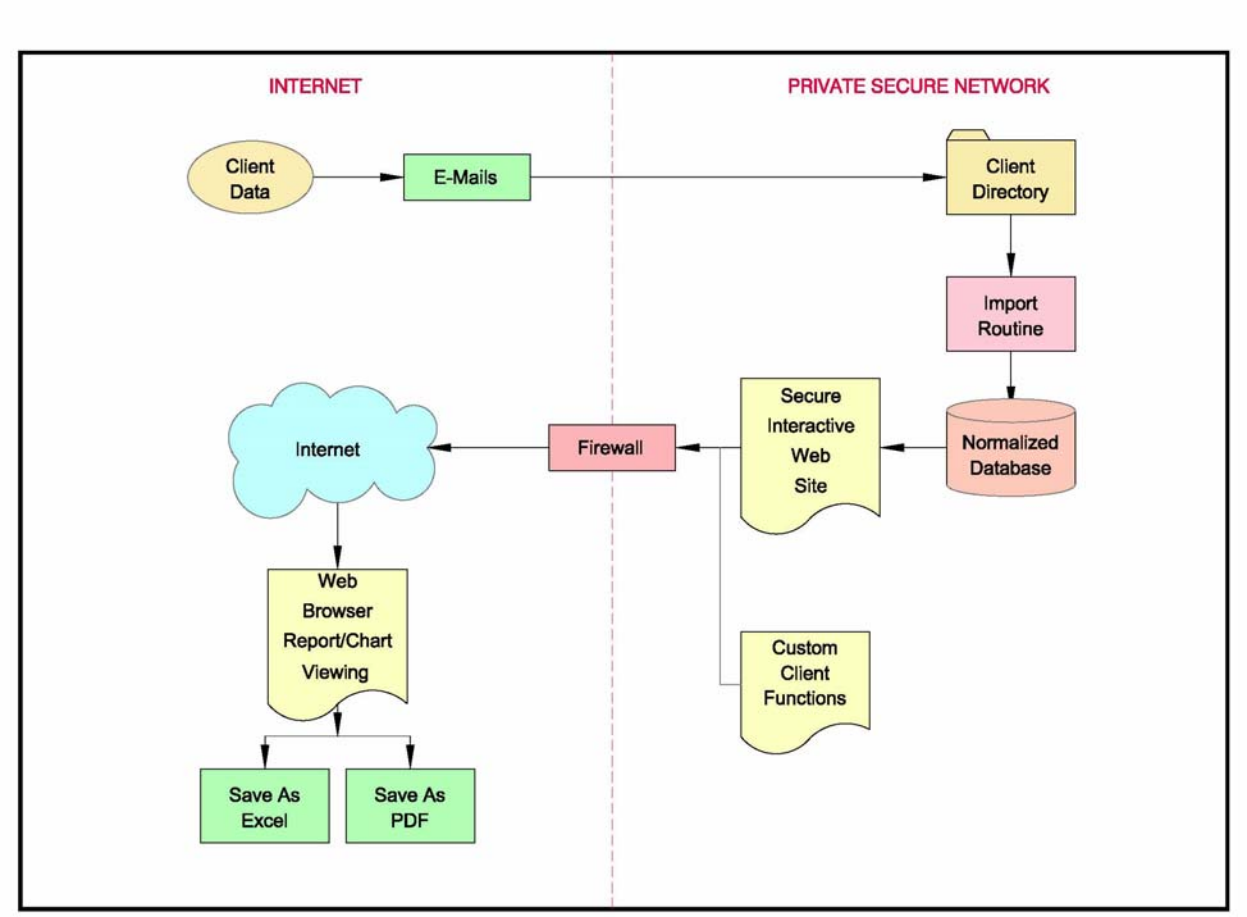


Figure 2. System configuration.

5. System output

Benchmarking reports are produced on a quarterly basis. On login, a participant is recognized and that company's data is displayed. Data is easily and quickly accessed from a dashboard that provides a quick overview of the relative performance on the company's equipment fleets compared to others for the last reporting period. An example dashboard is shown in Figure 3. In this figure, green identifies the company as the best performer in that metric, red as the worst performer and grey indicates a middle position. Entry into the reporting system is as easy as clicking on any button on the dashboard.

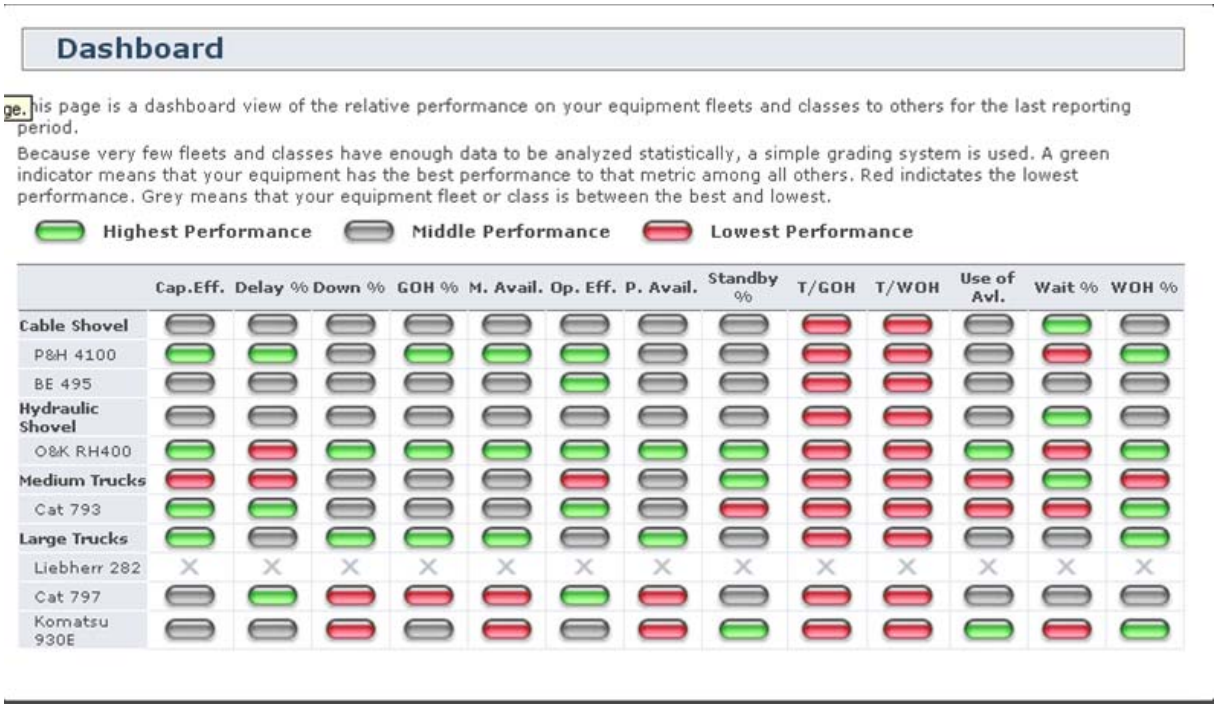


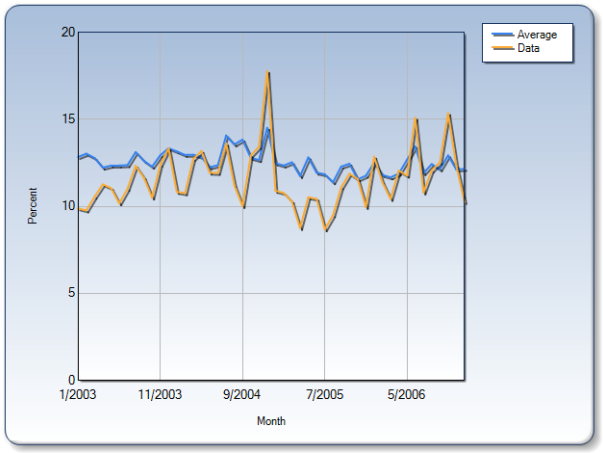
Figure 3. Dashboard.

The system provides users with interactive tools to view and analyze the benchmarking reports in both graphical and numerical formats. It also allows users to drill down into the reports and selectively view data by the following parameters:

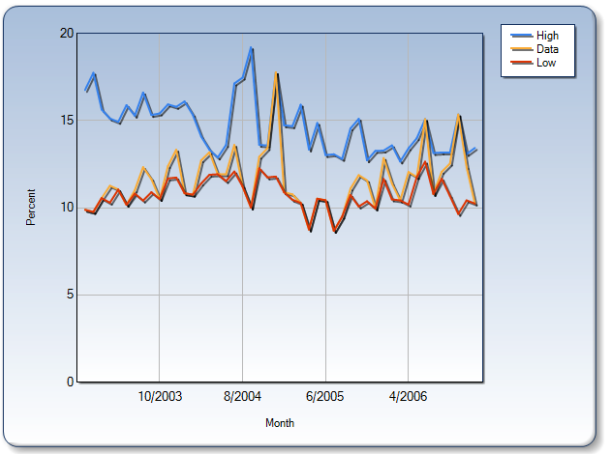
- equipment fleet;
- class of equipment;
- timescale;
- mine; and,
- selected metric.

Two examples graphical outputs are shown in Figure 4. On Graph #1, company performance for a selected metric (e.g. Mechanical Availability for a specified truck fleet) (yellow line) is compared to the average performance. In Graph #2, company performance is compared to the best and worst performers.

The report viewer also allows users to view the data in numeric format and to save it as an Excel™ file or Adobe™ PDF file for ease of export to company systems.



Graph #1



Graph #2

Figure 4. Example graphical output.

6. Benefits to participants

The Benchmarking Project provides a key tool to allow mining companies to understand their position in the industry and the resultant opportunities to achieve world-class performance. Some of the benefits that participating companies have reported include:

- analyze internal performance and between mines within one company;
- allows comparison of company performance against industry for the purpose of assessing performance capabilities and setting targets;
- assess and improve fleet operations and maintenance practices;
- detect problem areas within their operations;
- identify star performers in the industry and, through communications, the underlying Best Practices;
- exchange knowledge about common issues;
- owners and management have expressed a growing confidence in each operator's ability to identify internal strengths and weaknesses;
- identifying common equipment/manufacture problems;
- impact equipment purchasing decisions by understanding the capability of equipment in like applications;
- establish clarity around data definitions. Clarity around definitions for time allocation has helped remove misconceptions about local productivity comparisons;
- new measurement techniques for productivity analysis have been learned;
- exchange new ideas around measurement techniques; and
- combine information to help provide a common industry voice to communicate with equipment vendors.

Finally, the program has established a momentum for continuous improvement among the participants due to increased confidence in the benchmark numbers and newly opened doors of communication.

7. Future development

The next phase of the project is to step up promotion of the system in order to attract an increased number of participating companies. A larger database of equipment is required to fully realize the benefits of benchmarking. To date, discussions have been held with several North America and Internationally companies about their potential participation in the project.

It is also important to promote expanded communication between participating mines to realize the exchange of ideas and the implementation of Best Practices. To encourage this, Marston is investigating ideas such as setting up bulletin boards and dedicated chat rooms to facilitate a secure means of inter-companies communications.

The system was designed so that, as more participants enroll in the program, additional functionality can be added. Potential future enhancements that are being investigated include:

- enable on-line data submittals;
- expand equipment statistics that are collected (e.g. equipment age). This is limited only by the statistics that are currently collected by the mining companies;
- expand the range of maintenance and organizational productivity metrics that are reported;
- increase the types of equipment that are reported on (e.g. add Draglines and support equipment);
- add additional reporting capabilities, as requested by participants;
- expand viewing capabilities (e.g. ability to select profiles by industry or terrain); and,
- enhance the ranking system between company performance.

8. Conclusions

While most mining companies now have internal systems in place to measure the utilization of their equipment, few mines evaluate their performance against the industry. Benchmarking provides the tools to enable this comparison. It also provides the means to identifying leaders in the industry with outstanding performance and the underlying Best Practices.

The analysis of statistical performance data is only the first step. The distinctive characteristic of the SMART Benchmarking Project, compared to other market evaluations of industry position, is the collaborative spirit of the participating companies to use the data for more than just presentations. In addition to allowing companies to compare their relative performance against the industry, the system identifies areas of superior performance and allows participants to discover the underlying Best Practices. Through SMART, participating companies can then, in turn, work together to share these same Best Practices.

For more information on SMART, go to *www.smartmines.com*. Information on the Benchmarking Project can be found at *benchmarking.smartmines.com*.

Notes on contributor

Dr. Louise Michaud is a registered professional engineer with over 25 years of experience in Mining and Environmental Engineering, including working at operating mines, for the consulting industry, and as a university professor. She has worked for oil sands, coal, base metals, construction materials and industrial mineral operations, as well as for the telecommunications and power generating industries. Her experience includes working on projects in Canada, the USA, Mexico, the South Pacific and several Central and South American countries. Her areas of expertise include mine engineering, the integration of information technology in mine planning and operations, reserves estimations, operational due diligence reviews and audits, permitting, environmental management and impact assessments, mine reclamation and closure, and acid rock drainage.

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